Ambulatory Care Groups: A Categorization of Diagnoses for Research and Management

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This article describes a case-mix measure for application in ambulatory populations. The method is based primarily on categorization of diagnoses according to their likelihood of persistence. Fifty-one combinations (the ambulatory care groups or ACGs) result from applying multivariate techniques to maximize variance explained in use of services and ambulatory care charges. The method is tested in four different HMOs and a large Medicaid population. The percentage of the population in each of the 51 categories is similar across the HMOs; the Medicaid population has higher burdens of morbidity as measured by more numerous types of diagnoses. Mean visit rates for individuals within each of the 51 morbidity categories are generally similar across the five facilities, but these visit rates vary markedly from one category to another, even within groupings that are similar in the number of types of diagnoses within them. Visit rates for individuals who stay in the same ACG were similar from one year to the next. The ACG system is found useful in predicting both concurrent and subsequent ambulatory care use and

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charges as well as subsequent morbidity. It provides a way to specify case mix in enrolled populations for research as well as administration and reimbursement for ambulatory care.

Hospitalizations have commanded most of the attention concerning cost controls and quality of care. In recent years, however, rates of hospitalization and length of stay have declined. Despite the decline in hospitalization, costs of care continue to rise, largely because of an increase in the number of outpatient visits and procedures. From 1981 to 1987, the number of inpatient days fell 26 percent, while the number of outpatient visits per 1,000 people rose 26 percent and costs per patient day rose 88 percent (Kramer 1988). This increasing use of outpatient services is generating interest in methods to examine the nature and extent of variations in ambulatory medical practice (Eisenberg 1986).

The study of morbidity and costs in ambulatory care presents challenges that differ from hospital care (Gold 1988). There are many more types of settings with many more providers. The endpoint is ill-defined and a large number of units of service have relatively small costs per unit of service. Inpatient care generally involves one or at most a few diagnoses, whereas in ambulatory care many diagnoses are often made, especially over a period of time. Data bases are poorly developed and bills are often generated at multiple sites (e.g., from referrals and diagnostic tests). Information on the care rendered in most ambulatory settings is generally specific to the visit because reimbursement is based on fee-for-service; linkage of data from one visit to another to provide information on health problems that patients experience over time is rarely possible. The rapid expansion of capitated and managed systems of care is making it possible to document the health care experiences of individuals over time and to examine the nature of practice variations in their care.

Currently available methods for specifying case mix are largely visit based, for example, the Ambulatory Visit Group System (Ambulatory Care Project Staff of Yale University 1987) and its modifications (Schneider, Lichtenstein, Freeman, et al. 1988); the Products of Ambulatory Care or PACs (Tenan, Fillmore, Caress, et al. 1988); the Ambulatory Services Weighting System or ASWS (Young, Joyce, Blivens, et al. 1988); and the Ambulatory Severity Index or ASI (Horn, Buckle, and Carver 1988). In order to use these in an HMO setting or where an inclusive capitation rate needs to be set, visit-based measures would require modification to permit aggregation over time.

Stimson and colleagues developed a procedure to classify ambulatory care over time (Stimson, Charles, and Rogerson 1986). The system requires linkages of diagnoses and their associated procedures and medications from medical records or claims forms. Such linkages are generally only available from problem-oriented record systems. To our knowledge, this system has been tried in only one facility (a veterans hospital outpatient facility). Thus, no systems currently exist to categorize the constellation of ambulatory care diagnoses over time in individuals or in populations in general ambulatory care settings.

This article has two objectives: (1) to present a system to measure and compare the burden of illness of patients over time in different ambulatory care facilities, and (2) to show how the system can predict utilization and charges, both concurrently and prospectively.

The system, known as the Ambulatory Care Groups (ACGs), was derived from prior work that examined the relationship between morbidity and use of services among children enrolled in an HMO over a six-year period (Starfield, Hankin, Steinwachs, et al. 1985). In that study, diagnosed morbidity was categorized into 1 of 14 groups, depending on the likelihood that the diagnosis would be self-limited, likely to recur over time, chronic medical, chronic specialty, or psychosocial/psychosomatic. When morbidity was categorized in this way and related to utilization over the six-year period, children with multiple types of diagnoses were more likely to be persistently high users than were other children. The findings were confirmed by a community survey in which mothers and teachers of a subsample of the same children were surveyed to determine their reports of morbidity and functional status; multiple types of morbidity were also found to be related to the likelihood of utilization in a subsequent two-year period (Diaz, Starfield, Holtzman, et al. 1986). This categorization of morbidity was also found useful in examining the relationship between types of morbidity in individual children over time (Starfield, Katz, Gabriel, et al. 1984). The categorization was subsequently modified for use in adults in a study that examined the relationship between use of services by parents and by their children (Schor et al. 1987).

For this study, which included both adults and children, the original morbidity groups were expanded further into an eventual 34 groups, called ADGs (ambulatory diagnostic groups). The primary conceptual basis, as in the original system, was the expected persistence or recurrence of the condition over time. Other considerations included (in decreasing order of priority):

1. Likelihood that the patient would have a return visit for the condition;
2. Likelihood of a specialty consultation or referral;
3. Expected need and cost of diagnostic and therapeutic procedures associated with the condition;
4. Likelihood of an associated hospitalization;
5. Likelihood of associated disability; and
6. Likelihood of associated decreased life expectancy.

METHODS

DERIVATION OF CATEGORIES

The aggregations of diagnostic codes were developed from the data base at one HMO (the Columbia Medical Plan in Maryland); analyses at the other sites were conducted on the system developed at the one HMO. In that HMO, the coding system was compatible with ICD-8. It was necessary to convert all individual diagnostic codes to ICD-9 to permit comparisons across the sites in this study and to facilitate more general use. This process resulted in a dictionary of 3,924 distinct ICD-9 codes. In addition, the 930 most frequent ICD-9-coded diagnoses from the National Ambulatory Medical Care Survey 1981 file (capturing over 90 percent of all NAMCS visits) were reviewed; 144 additional ICD-9 diagnoses were added, resulting in a dictionary of 4,068 out of the approximately 10,000 diagnostic listings in the ICD-9. Using the above criteria, each of these 4,068 diagnoses were assigned to 1 of 20 morbidity categories by two physicians, an internist (L.M.) and a pediatrician (B.S.), first working independently and then meeting to resolve discrepancies. In some cases, particularly for unusual diagnoses related to ophthalmologic, otolaryngologic, or dermatologic conditions, advice was sought from appropriate specialists. The vast majority of codes (well over 90 percent) were assigned without discrepancy. To test and refine the expert judgments, analyses of "transition probabilities" were conducted for the diagnoses on the computerized medical encounter forms of the 7,800 HMO members continuously enrolled over a six-year period. The purpose of this step of the analysis was to determine the extent to which diagnoses in each category were present in a subsequent year, as compared with the probability that they would have occurred again by chance. (The primary conceptual basis for the diagnostic categorization was maximal separation of groups according to differences in their likelihood of persistence from one time period to another.) This process served as a validation of the clinical judgments as well as an indication of where further attention to classification was required. (An example of this procedure and its results is found in Starfield, Katz, Gabriel, et al. 1984, Table 3.) Individual diagnoses that were changed from one category to another as a result of this process were those that were originally difficult to categorize by clinical judgment alone.

We determined the extent to which each of the 20 morbidity categories was statistically independent of the others. In this "patient-level" analysis, the correlation coefficients for each pair of diagnostic categories were quite low, suggesting that the categories were measuring relatively independent morbidity-related attributes. The resulting groups, with a list of the most common diagnoses within the group, and a list of remaining problematic individual diagnoses (such as tuberculosis, "history of" various conditions, and "prematurity") were sent to consultants, each of whom had a national reputation both in health services research and clinical medicine. These included a general internist, a general pediatrician, a family physician, and a physician who had worked previously with the earlier child and adult classifications. In cases where the expert judges disagreed on placement of the specific problematic diagnoses, transition probabilities were run on the individual diagnoses, which were then placed with the most similar category. (These contentious diagnoses included iron deficiency anemia, sinusitis, blepharitis, hepatitis, gastritis, seborrhea, scoliosis, and verrucae.) A general consensus among the consultants was that, while the classification was adequate in tapping the dimensions of persistence and intensity of services over time, it did not adequately tap the dimension of severity. As a result, the categorization was expanded from 20 to 34, in order to permit the separation of more serious conditions (e.g., meningitis, polyarthritis) from those that are less serious (e.g., upper respiratory infection, torticollis).

THE AMBULATORY DIAGNOSTIC GROUPS (ADGs)

This process resulted in 34 groups, designated as ambulatory diagnostic groups (ADGs). Appendix Table A1 presents the ADGs and common diagnoses within them.

Computerized patient records for at least one year were created at each of the study sites. At the original HMO (Columbia Medical Plan—CMP), data were obtained for 1974–1979. At Maxicare (a network HMO based in Los Angeles), MedCenters Health Plan—MCHP (a staff/group HMO in Minneapolis), and the Harvard Community Health Plan—HCHP (a staff/group HMO in Boston), data were from 1980 or 1981. Claims for over 30,000 continuously eligible Medicaid recipients in Baltimore, Maryland were obtained for 1984–1985. Except for the Medicaid population, each record contained all diagnoses, age, sex, and measures of resource consumption. (For the Medicaid population, only one diagnosis per visit was available.) Using a "grouper" program, each diagnostic code was assigned to one and only one ADG. (Details about the grouping process are contained in a companion paper by Weiner et al., in press.) The procedures are now summarized.

The total number of possible combinations of the 34 ADGs is too large to be of practical use either in research studies or in management strategies. A reduction in the number of possible categories of morbidity was accomplished in a manner similar to that used in the development of Medicare DRGs (Fetter, Youngsoo, Freeman, et al. 1980), except that total ambulatory visits over a year was the dependent variable. Like the DRG process, the Yale AUTOGRP program (Theriault 1979) identified which of the independent variables (diagnostic category, age, or sex) would best define the final groupings. In order to select the partitioning strategy from the innumerable possible choices, we used data from the CMP population to form collapsed ADGs (CADGs). These are 12 collapsed groupings of ADGs similar in their likelihood of persistence (Appendix Table A2).

THE TERMINAL (AMBULATORY CARE) GROUPS (ACGs)

We then formed MACs (major ambulatory categories), which are mutually exclusive combinations of CADGs, by identifying the 23 most common combinations of CADGs. On the first AUTOGRP partition, each individual was placed into one of these 23 groups. Appendix Table A3 contains a list of the 23 MACs and shows their derivation from the CADGs; an additional group was formed for individuals who had other combinations of CADGs in the year. After each member of the population was assigned to one (and only one) of the MACs, we queried the AUTOGRP for the best possible (according to variance reduction) partitioning using the individual ADGs, age, and sex. Recursive partitioning was allowed to continue until a terminal group contained fewer than 30 individuals or the variance reduction (of the average visit rate) achieved by the split amounted to less than 0.1 percent of the entire population's variance. This AUTOGRP process was repeated at the MCHP HMO and the final scheme (the ACGs) reflected a melding of the almost identical results at the two sites. The resulting ACGs, consisting of 51 groupings of diagnostic categories, were validated across all five study populations using multivariate analysis. A companion article describes the partitioning process in more detail and provides a graphic depiction of the ACG decision tree. (Weiner et al. in press).

RESULTS

Table 1 presents the distributions of adults and children in the five populations according to ACGs categorized by the number of types of diagnoses (ADGs) within them. The Medicaid population had a smaller proportion of individuals in categories with few types of problems and, conversely, had a larger proportion of individuals in ACG categories with large numbers of types of diagnoses, a finding that was especially marked in the case of adults. This is consistent with the greater morbidity among populations of lower social class (Dutton 1986), and is especially noteworthy since the number of diagnoses that were coded for the Medicaid population was *less* than for the other populations (because only one diagnosis per visit was available). The somewhat greater proportion of individuals in categories with fewer types of diagnoses in the Maxicare HMO may be a result of the use of an encounter form that contains relatively few "check-off" diagnoses and is supplementary to (rather than substituting for) the medical record.

Table 2 presents the mean utilization for individuals in each of the ACGs in the five populations. The table shows the generally similar level of use across the populations when morbidity is "controlled" using the ACGs. It also shows that individuals in different ACGs have different levels of use even within ACG categories having the same number of different types of diagnoses (ADGs). In particular, individuals with psychosocial diagnoses, whether alone or in combination with other types of diagnoses, have relatively high levels of use. Infants (under age 2) are also relatively high users. The increasing level of use among individuals with multiple types of morbidity is especially noteworthy.

In one of the settings (CMP), data were available for successive years. The next two tables provide information on the stability of ACG designation and utilization from one year to the next. Table 3 summarizes information on the extent to which individuals tend to stay in the same or related ACG category from one year to the next. Although the

Table 1: Percent Distribution of Individuals in Ambulatory Care Group Categories, by Number of Types of Morbidity

	Population									
	Adults (Age 17+)					Children (Age 0–16)				
*Number of Types of Morbidity**	*CMP*	*Med Center*	*Maxi Care*	*HCHP*	*Maryland Medicaid*	*CMP*	*Med Center*	*Maxi Care*	*HCHP*	*Maryland Medicaid*
1–2	39.2%	38.7%	43.5%	32.2%	15.8%	39.9%	41.7%	52.9%	40.2%	35.7%
3	36.1	35.1	35.9	31.5	29.3	45.8	44.4	38.0	42.4	43.3
4–5	14.6	15.9	13.0	19.7	21.0	6.2	9.1	5.2	10.0	9.3
6–9	6.3	9.3	5.2	14.1	22.6	3.9	4.5	1.7	6.4	7.9
10+	0.5	1.0	0.4	2.2	9.3	0.2	0.2	0.1	0.6	1.3
No diagnosis	3.3	0.1	2.0	0.4	2.0	4.0	0.1	2.1	0.4	2.5
	100.0%	100.1%	100.0%	100.1%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

*As defined by the average number of ambulatory diagnostic groups (ADGs) within the ACG.

Table 2: Average Annual Visit Rate* by Ambulatory Care Group for Individuals at Each Ambulatory Site

	CMP (*N = 6,659*)	*MCHP* (*N = 28,005*)	*Maxicare* (*N = 25,732*)	*HCHP* (*N = 25,731*)	*Medicaid* (*N = 20,424*)
One Ambulatory Diagnostic Group (ADG)					
ACG01 Acute Minor, Age <2	6.78	4.59	4.32	5.44	4.55
ACG02 Acute Minor, Age 2-5	2.84	2.67	2.39	2.81	2.73
ACG03 Acute Minor, Age 6+	2.41	1.95	2.04	1.96	1.72
ACG04 Acute Major	2.52	2.30	2.04	1.90	1.63
ACG05 Likely to Recur, w/o Allergies	2.75	2.41	2.49	2.24	1.92
ACG06 Likely to Recur, w/Allergies	2.47	4.89	2.56	3.57	1.52
ACG07 Asthma	1.87	5.40	2.38	2.28	1.63
ACG08 Chronic Medical, Unstable	3.71	3.17	2.65	2.57	1.53
ACG09 Chronic Medical, Stable	3.68	1.94	2.47	2.14	2.25
ACG10 Chronic Specialty, Stable	2.60	2.01	1.34	1.48	1.00
ACG11 Ophthalmological/Dental	2.06	1.53	0.67	1.77	0.60
ACG12 Chronic Specialty, Unstable	1.75	2.24	2.08	1.77	1.24
ACG13 Psychosocial, w/o Psych—Major	3.33	3.44	1.95	2.01	1.43
ACG14 Psychosocial, w/Psych—Major, w/o Psych—Minor	7.54	4.27	3.07	5.27	3.47
ACG15 Psychosocial, w/Psych—Major, w/Psych—Minor	6.40	8.29	6.00	5.80	3.57
ACG16 Prevention/Administrative	1.59	1.37	1.51	1.41	0.98
ACG17 Pregnancy	7.56	7.66	6.82	5.30	3.40
Two-Three ADGs					
ACG18 Acute Minor(Mi) + Acute Major(Ma)	4.53	3.93	3.80	3.46	3.84
ACG19 Acute Mi + LRDi, Age <2	8.85	9.05	7.61	8.45	7.74
ACG20 Acute Mi + LRDi, Age 2-5	5.69	5.72	5.39	5.56	5.53
ACG21 Acute Mi + LRDi, Age >5, w/o Allergies	4.34	3.79	4.11	3.80	3.52
ACG22 Acute Mi + LRDi, Age >5, w/Allergies	4.71	6.12	4.06	5.35	4.91

Continued

Table 2: Continued

	CMP (N = *6,659*)	*MCHP* (N = *28,005*)	*Maxicare* (N = *25,732*)	*HCHP* (N = *25,731*)	*Medicaid* (N = *20,424*)
Two-Three ADGs					
ACG23 Acute Mi + Chronic Medical, Stable	3.91	3.09	3.72	3.37	3.80
ACG24 Acute Mi + Eye/Dental	2.81	3.05	2.31	3.31	2.47
ACG25 Acute Mi + Psychosocial w/o Psych – Ma	4.60	4.21	3.62	3.47	3.45
ACG26 Acute Mi + Psychosocial, w/Psych – Ma, w/o Psych – Mi	5.61	5.24	4.95	7.31	4.81
ACG27 Acute Mi + Psychosocial, w/Psych – Ma, w/Psych – Mi	9.50	10.64	6.00	7.77	6.30
ACG28 Acute Ma + Likely to Recur, Discrete	4.65	4.29	4.20	3.71	3.18
ACG29 Acute Mi + Acute Ma + LRDi, Age <2	13.05	11.55	10.54	10.99	11.42
ACG30 Acute Mi + Acute Ma + LRDi, Age 2–5	8.17	8.00	7.60	7.43	7.81
ACG31 Acute Mi + Acute Ma + LRDi, Age 6–11	6.43	7.09	5.38	5.30	6.32
ACG32 Acute Mi + Acute Ma + LRDi, Age >5 w/o Allergies	6.57	5.96	6.34	5.30	6.18
ACG33 Acute Mi + Acute Ma + LRDi, Age >5 w/Allergies	7.00	8.96	6.80	5.87	5.94
ACG34 Acute Mi + LRDi + Eye/Dental	4.60	5.23	4.79	5.23	5.58
ACG35 Acute Mi + LRDi + Psychosocial	10.33	8.05	6.85	7.40	6.34
ACG38 2–3 Other ADG Combos, Age <17	3.71	4.64	3.70	3.25	3.51
ACG39 2–3 Other ADG Combos, Males, Age 17–34	3.89	3.65	3.36	3.94	2.87
ACG40 2–3 Other ADG Combos, Females, Age 17–34	7.70	6.20	7.00	4.78	3.47
ACG41 2–3 Other ADG Combos, Age >34	4.49	3.94	4.12	4.14	4.28

Four–Five ADGs					
ACG36 Acute Mi + Acute Ma + LRDi + Eye/Dental	9.84	8.06	8.52	6.99	8.97
ACG37 Acute Mi + Acute Ma + LRDi + Psychosocial	12.23	10.97	10.30	9.00	10.90
ACG42 4–5 Other ADG Combos, Age <17	6.65	8.36	6.41	5.70	6.59
ACG43 4–5 Other ADG Combos, Age 17–44	8.99	7.17	7.41	6.21	5.83
ACG44 4–5 Other ADG Combos, Age >44	6.39	6.03	6.52	5.85	7.35
Six–Nine ADGs					
ACG45 6–9 Other ADG Combos, Age <6	12.41	14.55	13.94	10.49	12.02
ACG46 6–9 Other ADG Combos, Age 6–16	9.30	10.67	8.74	8.23	10.17
ACG47 6–9 Other ADG Combos, Males, 17–34	8.90	10.72	9.80	8.54	8.83
ACG48 6–9 Other ADG Combos, Females, Age 17–34	13.39	11.23	11.90	9.85	9.20
ACG49 6–9 Other ADG Combos, Age >34	11.17	9.80	10.65	9.84	11.36
ACG50 10+ Other ADG Combos	19.91	18.15	17.65	15.58	19.12
ACG51 No Visits and/or No ADGs	1.76	1.14	1.24	1.10	0.02
All Users	4.80	4.77	4.13	4.92	5.66

*A table providing more detail including coefficients of variation is included in Weiner et al. 1991

Table 3: Percent of Individuals with Identical Number of Types of Morbidity in Two Successive Years Compared with Population Distribution by Number of Types of Morbidity in Second Year

	Adults		Children	
*Number of Types of Morbidity**	*Percent of Population in Category in Year 2*	*Percent of Individuals in Category in Year 1 Who Remain in Category in Year 2*	*Percent of Population in Category in Year 2*	*Percent of Individuals in Category in Year 1 Who Remain in Category in Year 2*
1-2	31.4%	38.9%	29.1%	38.1%
3	33.7	36.5	48.0	55.6
4-5	15.2	23.7	8.2	13.2
6-9	8.2	24.6	5.5	18.7
10+	0.5	22.2	0.2	0.6
No diagnosis	11.0	23.8	9.0	3.9
	100.0%		100.0%	

*As defined by the average number of ambulatory diagnostic groups (ADGs) within the ambulatory care group (ACG).

Table 4: Mean Utilization in Two Successive Years for Individuals in Groupings Categorized According to Number of Types of Morbidity in Year 1

Number of Types of Morbidity in Year 1*	*Number of Individuals*		*Mean Number of Visits*			
			Adults		*Children*	
	Adults	*Children*	*Year 1*	*Year 2*	*Year 1*	*Year 2*
1-2	1468	1165	2.7	3.6	2.4	3.2
3	1351	1338	5.2	5.4	5.4	5.2
4-5	545	182	8.7	7.7	7.1	6.7
6-9	236	113	11.9	10.8	10.4	8.1
10+	18	5	19.1	20.8	22.8	13.8
No diagnosis	122	116	1.6	3.0	2.0	2.8

*As defined by the average number of ambulatory diagnostic groups (ADGs) within the ambulatory care group (ACG).

table presents data in greatly summarized form, the findings are the same when the data are arrayed by each separate ACG. That is, individuals in a given ACG in one year are much more likely to be in that same ACG in the next year than is the case for the general population at that facility.

Table 4 presents mean utilization in two successive years for individuals in ACG categories grouped by the number of individual

Table 5: Summary of Total Variance Explained by Ambulatory Care Groups (ACGs) and its Components by Type of Regression Model, Site, Dependent Measures, and Year (All Figures Represent Adjusted R-Square of Regression Equations)

	Dependent Measures				
	Ambulatory Visits		*Ambulatory Charges*		*Total Charges*
	Yr. 1	*Yr. 2*	*Yr. 1*	*Yr. 2*	*Yr. 1*
Model A: Age Group, Sex					
CMP	.05	.05	.03	.03	
MCHP					.04
Maxicare	.06		.06		
HCHP	.03				
Model B: Age Group, Sex, ADG Dummies (i.e., Yes/No for each ADG)					
CMP	.59	.23	.46	.21	
MCHP	.52		.47		.19
Maxicare	.57		.49		
HCHP	.40				
Medicaid-AFDC	.48		.42		
Model C: 51 ACGs					
CMP	.50	.20	.38	.18	
MCHP	.44		.38		.15
LA-Maxicare	.45		.39		
HCHP	.32				
Medicaid-AFDC	.42		.34		

ACGs. The table indicates generally similar levels of use once the number of ACGs is controlled, but increasing use in both years with increasing numbers of ACGs. Moreover, levels of utilization for individuals in the same ACG in both years remain relatively constant from one year to the next (data available on request), rather than regressing toward the mean. This finding indicates the stability of average utilization once case mix is controlled.

At all sites, it was possible to determine how well age, sex, and morbidity classification explained resource consumption for the same year. At the CMP it was also possible to determine the predictiveness of these variables for resource consumption in the subsequent year. Table 5 contains the results of regression analyses for age and sex alone (model A); age and sex and the 34 individual ADGs (model B); and for the 51 ACGs, which include age and sex within them (model C). Table 5 indicates that over 30 percent (and, in some cases, well over 50 percent) of the variance in number of visits and ambulatory charges is explained by models that include morbidity as categorized by the ACG method, as compared with only 3–6 percent for age and sex alone. The predictiveness of the models for resource use in the same year as the morbidity experience was about twice its predictive power for the subsequent year of utilization. But even in the case of future resource consumption, the model with ACGs explained over 20 percent of the variance in visits and ambulatory charges in the subsequent year.

Discussion

In this article we describe a categorization of morbidity that has applicability in research, in management, and for reimbursement.

By focusing on comorbidity as well as on the type of illness, the method can facilitate the exploration of common antecedents of different types of morbidity. Accounting for comorbidity is an important feature of a case-mix measure, as comorbidity has been shown to be key in assessing the quality of care (Greenfield et al. 1988; Pompei, Charleson, and Douglas 1988). By explicitly recognizing combinations of types of disorders, the ACG system serves as a measure of "case mix" at the individual level as well as at the population level. Assessment of outcomes of care across providers, or across different settings or populations, requires knowledge of and control for initial health status (Palmer 1988); this can be addressed by the ACG method. Furthermore, the system can itself facilitate study of certain aspects of the quality of care. For example, where there appear to be substantial differences across facilities in the frequency of specific ACGs (e.g., those containing psychosocial diagnoses), systematic underdiagnosis (or overdiagnosis) might be suspected.

Studies of medical practice variations and utilization review might also be facilitated by use of the ACG system. Data from Table 2 illustrate this potential. Although the relative ranking of average utilization across ACG categories was similar in the five populations, there were some apparent differences in average utilization for particular types of diagnoses. For example, what explains the higher visit rate in ACG 10 relative to ACG 12 in the Columbia Medical Plan, whereas the reverse is true in the other facilities? Do specialists in CMP initiate more routine follow-up visits for stable conditions than specialists in the other facilities? Utilization levels within each ACG category appeared to be higher in one of the HMOs than in the other HMOs, except for one group of patients (those with allergies), wherein utilization was systematically higher in another of the HMOs. Thus, stratification by type of morbidity, as with the ACG method, elucidates apparent medical practice variations that are not evident in comparisons of overall utilization by their populations.

The coefficients of variation of ambulatory care utilization for each ACG (shown in Weiner et al. in press) were lower than the coefficient of variation for overall ambulatory care use in each of the five populations. Although the coefficients of variation for some of the ACG categories tended to be relatively high (.8 or more), for some types of diagnoses (especially chronic medical conditions both stable and unstable, and major psychosocial diagnoses), most coefficients were in the range of .4–.7. A notable exception was the Medicaid population where coefficients of variation were uniformly higher than for the populations enrolled in the HMOs. This may be a result either of greater heterogeneity in severity of illness within ACG categories in the Medicaid population or of differences in practice patterns among the variety of providers used by this population.

The ACGs also have potential usefulness as a management tool, where it is desirable to tailor payment levels to differences in levels of morbidity. At present, prospective pricing is hampered by the lack of an acceptable method of specifying differences in medically related needs of enrolled populations. Current approaches to setting rates for capitation have major limitations. In Medicare's AAPCC (average adjusted per capita cost) method, the projected national average cost per capita for all Medicare beneficiaries is calculated and then adjusted for variations in costs across geographic areas. Projected costs for an HMO are calculated by adjusting this figure according to age, sex, institutional status (e.g., nursing home), and Medicaid or non-Medicaid. This method has been found to predict costs poorly (Anderson et al. 1986a), and to perpetuate inefficiencies in existing practice.

Proposed modifications of the AAPCC method also contain problems. Inclusion of prior utilization greatly improves prediction of future costs (Anderson and Knickman 1984), but its incorporation into a reimbursement system would reward provider organizations that have been unable to control utilization. Adjustments for self-perceived health status or functional status would be helpful (Thomas et al. 1983; Wasson, Sauvigne, Balestra, et al. 1987), but this information would be cumbersome to obtain and could be influenced by biased responses of enrollees (Anderson 1986b).

Several criteria have been applied in judging the potential usefulness of the ACG system. Among these are reliability, validity, sensitivity, practicality, and acceptability (Hornbrook 1982; Wood, Ament, and Kobrinski 1981). The similarity of the distributions of individual as well as grouped ACGs across similar HMO populations suggests its reliability. Its validity derives from its emphasis on morbidity, long known to be the most salient correlate of resource use. Its sensitivity in distinguishing differences in burdens of illness is indicated by the differences in the expected direction between the HMO populations and a Medicaid population. The ACG system is inexpensive to apply, because it derives directly from routinely collected information. Subsequent research might focus on developing a way to incorporate diagnoses from hospitalizations, so that prediction of total costs is more closely approximated.

Mention should be made of the potential for "gaming," that is, an alteration in physician behavior in order to minimize the intended effects of a process. Although gaming is possible in all new systems, a method of case-mix adjustment that is based on utilization is particularly susceptible, because physicians can readily initiate visits by providing appointments for follow-up. A system based on diagnosis might be gamed by encouraging the recording of more diagnoses, thus leading to classification of patients into higher reimbursement categories. However, this can be addressed in two ways: by periodically recalibrating reimbursement levels for the ACG categories, and by quality of care reviews to monitor the appropriateness of diagnoses. The acceptability and usefulness of the ACGs will ultimately depend on the results of their application in research and management by clinicians, investigators, and administrators.

APPENDIX

Table A1: The Ambulatory Diagnostic Groups (ADGs) and Examples of Common ICD-9-CM Diagnoses Falling into Each ADG

ADG	*Common Diagnosis (ICD-9-CM Code)*
1. Time Limited: Minor	Dermatitis (692.9)
2. Time Limited: Minor—Primary Infections	Acute upper respiratory infection (465.9)
3. Time Limited: Major	Synovitis (727.09)
4. Time Limited: Major—Primary Infections	Pneumonia (486)
5. Allergies	Allergic rhinitis (477.9)
6. Asthma	Asthma (493.90)
7. Likely to Recur: Discrete	Vaginitis (616.10)
8. Likely to Recur: Discrete—Infections	Otitis media (382.9)
9. Likely to Recur: Progressive	Diabetic ketoacidosis (250.10)
10. Chronic Medical: Stable	Hypertension (401.9)
11. Chronic Medical: Unstable	Coronary Atherosclerosis (414.0)
12. Chronic Specialty: Stable—Orthopedic	Chondromalacia patellae (717.7)
13. Chronic Specialty: Stable—Ear, Nose, Throat	Hearing loss (389.9)
14. Chronic Specialty: Stable—Eye	Refraction disorder (367.9)
15. Chronic Specialty: Stable—Other	Polycystic ovaries (256.4)
16. Chronic Specialty: Unstable—Orthopedic	Juvenile osteochondrosis (732.4)
17. Chronic Specialty: Unstable—Ear, Nose, Throat	Chronic sinusitis (473.9)
18. Chronic Specialty: Unstable—Eye	Glaucoma (365.9)
19. Chronic Specialty: Unstable—Other	Pseudotumor cerebri (348.2)
20. Dermatologic	Acne (706.1)

Continued

Table A1: Continued

ADG	*Common Diagnosis (ICD-9-CM Code)*
21. Injuries/Adverse Effects: Minor	Ankle sprain (845.00)
22. Injuries/Adverse Effects: Major	Tear of meniscus (836.0)
23. Psychosocial: Chronic	Depression (300.4)
24. Psychosocial: Other	Adjustment reaction (309.9)
25. Psychophysiologic	Migraine (346.9)
26. Signs/Symptoms: Minor	Headache (784.0)
27. Signs/Symptoms: Uncertain	Palpitation (785.1)
28. Signs/Symptoms: Major	Chest pain (786.50)
29. Discretionary	Sebaceous cyst (706.2)
30. See and Reassure	Skin scar/Fibrosis (709.2)
31. Prevention/Administrative	Routine medical exam (V70.0)
32. Malignancy	Malignant skin neoplasm (173.9)
33. Pregnancy	Pregnant state (V22.2)
34. Dental	Chronic gingivitis (523.1)

Table A2: The "Collapsed" Ambulatory Diagnostic Groups (CADGs) and the Ambulatory Diagnostic Groups (ADGs) That Comprise Them

ADG	*CADG*
1. Time Limited: Minor 2. Time Limited: Minor—Primary Infections 21. Injuries/Adverse Effects: Minor 26. Signs/Symptoms: Minor	1. Acute: Minor
3. Time Limited: Major 4. Time Limited: Major—Primary Infections 22. Injuries/Adverse Effects: Major 27. Signs/Symptoms: Uncertain 28. Signs/Symptoms: Major	2. Acute: Major
5. Allergies 7. Likely to Recur: Discrete 8. Likely to Recur: Discrete—Primary Infections 20. Dermatologic 29. Discretionary	3. Likely to Recur
6. Asthma	4. Asthma
9. Likely to Recur: Progressive 11. Chronic Medical: Unstable 32. Malignancy	5. Chronic Medical: Unstable
10. Chronic Medical: Stable 30. See and Reassure	6. Chronic Medical: Stable
12. Chronic Specialty: Stable—Orthopedic 13. Chronic Specialty: Stable—Ear, Nose, Throat 15. Chronic Specialty: Stable—Other	7. Chronic Specialty: Stable
14. Chronic Specialty: Stable—Eye 34. Dental	8. Eye/Dental
16. Chronic Specialty: Unstable—Orthopedic 17. Chronic Specialty: Unstable—Ear, Nose, Throat 18. Chronic Specialty: Unstable—Eye 19. Chronic Specialty: Unstable—Other	9. Chronic Specialty: Unstable
23. Psychosocial: Chronic 24. Psychosocial: Other 25. Psychophysiologic	10. Psychosocial
31. Prevention/Administrative	11. Prevention/Administrative
33. Pregnancy	12. Pregnancy

Table A3: The Major Ambulatory Categories (MACs) and the Assignment of Different Combinations of CADGs to Each

MAC	*CADG or Combination of CADGs included in MAC**
1. Acute: Minor	CADG-1
2. Acute: Major	CADG-2
3. Likely to Recur	CADG-3
4. Asthma	CADG-4
5. Chronic Medical: Unstable	CADG-5
6. Chronic Medical: Stable	CADG-6
7. Chronic Specialty: Stable	CADG-7
8. Eye/Dental	CADG-8
9. Chronic Specialty: Unstable	CADG-9
10. Psychosocial/Psychophysiologic	CADG-10
11. Prevention/Administrative†	CADG-11
12. Pregnancy	CADG-12
13. Acute: Minor and Major	CADG-1 and CADG-2
14. Acute: Minor and Likely to Recur	CADG-1 and CADG-3
15. Acute: Minor and Chronic Medical Stable	CADG-1 and CADG-6
16. Acute: Minor and Eye/Dental	CADG-1 and CADG-8
17. Acute: Minor and Psychosocial/Psychophysiologic	CADG-1 and CADG-10
18. Acute: Major and Likely to Recur	CADG-2 and CADG-3
19. Acute: Minor and Major *and* Likely to Recur	CADG-1 and CADG-2 and CADG-3
20. Acute: Minor and Likely to Recur and Eye/Dental	CADG-1, 3, and 8
21. Acute: Minor and Likely to Recur and Psychosocial/Psychophysiologic	CADG-1, 3, and 10
22. Acute: Minor and Major and Likely to Recur and Chronic Medical: Stable	CADG-1, 2, 3, and 6
23. Acute: Minor and Major and Likely to Recur and Psychosocial/Psychophysiologic	CADG-1, 2, 3, and 10
24. All other combinations of CADGS *not* listed above	All other combinations not listed above
25. No visit or No ADG	No CADGs

*CADG = Collapsed Ambulatory Diagnostic Group.

† In addition to the CADGs listed, persons in MACs 1–23 *may* also have made one or more Prevention/Administrative visit(s) (CADG-11).

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